REMARKS

Applicant has read and considered the Office Action dated February 4, 2003 and the references cited therein. Claims 1, 4 and 15 have now been amended.

In the Action, a Restriction Requirement was placed on the application. Applicant had provisionally elected, with traverse, Group I (drawn to a method of fabrication, namely claims 1-18) in a telephone call placed to the Examiner on October 22, 2002. Affirmation of the provisional election was required in the Office Action. Without acquiescing to the statements made in the Restriction Requirement, Applicant confirms election of Group I, claims 1-18, with traverse.

Claim 15 was objected to because of a misspelled word. As requested by the Examiner, claim 15 has been corrected.

An obvious error has been corrected on line 10 of claim 1 where the expression "first surface layer" has been replaced by "first substrate layer". Also, on line 13 of claim 1, the expression "the microstructure" has been replaced by "the suspended microstructure".

In claim 4, on line 29 of page 14, the expression "a microplatform" has been replaced by "a suspended microplatform", as disclosed, for example, on line 22 of page 11.

The Examiner rejected former claims 1-3, 5-6, 8-10, and 12-13 as being anticipated by U.S. Patent No. 5,831,266 (JEROMINEK et al.).

U.S. Patent No. 5,831,266 by JEROMINEK et al. is well know to the applicant as Mr. Hubert JEROMINEK is the sole inventor of the present patent application. The U.S. Patent 5,831,266 describes a multilayer suspended microbridge structure (see Figure 1) comprising a substrate layer 1, a microstructure 22 and its microsupport 24. The microsupport 24 consists of two legs 14, each of the legs 14 extending along a vertical axis 25 and having a central upper cavity (column 7, lines 5-8). Preferably, each of the legs 14 has substantially the shape of an inverted hollow truncated pyramid (column 7, lines 35-37). Moreover, the legs 14 are <u>located at diagonally opposite corners</u> of the microstructure 22 (column 7, lines 43 to 45). If one compares

figure 1 of U.S. Patent No. 5,831,266 with Figures 3 and 6 of the present patent application, one sees totally different suspended microstructures. The microstructures shown in Figures 3 and 6 of the present patent application do not have legs (i.e. supports) having a central upper cavity within each leg, the legs having substantially the shape of an inverted hollow truncated pyramid, and the legs being located at diagonally opposite corners of the microstructure. The sloped support according to the present invention as shown in Figures 3 and 6 of the present patent application, results from a fabrication method that is very different than the fabrication method shown in U.S. Patent No. 5,831,266. For example, Figure 2B of U.S. Patent No. 5,831,266 shows a step of patterning and etching cavities 4 in the temporary layer 3. These cavities 4 can have perpendicular or sloped walls and are formed by combining a standard photolithographic process with reactive ion etching of the temporary layer 3 (column 8, lines 1 to 5). Please note that the use of a grey scale mask is not mentioned. It is known in the art that the standard photolithographic process makes use of <u>binary masks</u>, i.e. masks consisting of transparent and opaque regions but not grey scale masks with gradually variable optical transmittance. Moreover, the standard photolithographic process makes use of binary masks that produce a <u>step-like pattern in the photoresist layer</u> but not a continuous slope with a predetermined angle, as produced with a grey scale mask. It is known that imperfections in such processes as well as the parasitic effects such as diffraction may induce residual slopes in the photoresist layer. This step-like pattern, when transferred to the temporary layer by the reactive ion etching (RIE) produces successive steps. Depending on the etching process conditions as well as the properties of the temporary layer, these successive steps may become sloped in a practically incontrollable fashion. However, a continuous slope with a predetermined angle cannot be obtained.

Furthermore, if the standard photolithographic process and RIE etching of the temporary layer are followed by deposition and etching of a structural layer, the resulting legs (supports) may have sloped walls, but not in a controlled fashion. Consequently, the following removal of the temporary layer cannot lead to obtaining a microstructure with a sloped support having a continuous slope with a predetermined angle. Thus, the properties of the microstructure that depend on the continuous slope with the predetermined angle cannot be precisely controlled.

Furthermore, Figure 2B from U.S. Patent No. 5,831,266 shows a plateau and two cavities 4 having a form of truncated inverted pyramids. As was explained above, the walls of these pyramids <u>are not</u> sloped as described in claims 2 and 3 of this patent application. Moreover, the

text of U.S. Patent No. 5,831,266 does not state whether the slopes of both pyramidal cavities shown in Figure 2B are equal or different. This is in contradiction with claim 3 of the present patent application, which explicitly states that the predetermined angles are substantially equal.

Accordingly, it is believed that U.S. Patent No. 5,831,266 does not teach nor anticipate that which applicant regards as his invention, as provided for in new claim 1. As the remaining claims are dependent upon new claim 1, it is believed that these claims are also allowable.

The Examiner also rejects claims 1-3, 5-6, 8-10 and 12-13 as being unpatentable over U.S. Patent No. 5,831,266 in view of U.S. Patent No. 5,143,820 (KOTECHA et al.), further in view of U.S. Patent No. 5,744,284 (LAUB et al.), further in view of U.S. Patent No. 5,841,143 (TUMA et al.) and further in view of U.S. Patent No. 5,955,817 (DHULER et al.).

The Examiner alleges that the KOTECHA patent teaches fabrication of a multilayer microstructure having a sloped layer profile by grey scale mask exposure of a photoresist layer and a subsequent etching through this patterned photoresist. The KOTECHA patent teaches fabrication of a metal interconnecting wiring layer, but it does not teach fabrication of any three-dimensional suspended microstructures equipped with any sloped supports. Furthermore, the KOTECHA patent teaches forming a multiple thickness step-like layer of a photosensitive material such as photoresist having fully developed areas, partially developed areas and undeveloped areas. These areas have respectively no resist layer thickness, a partial resist thickness and a full resist thickness (column 2, lines 46 to 52 as well as column 4, lines 50 to 57). The required step-like but not sloped photoresist layer thickness profile is shown in Figure 1C. Furthermore, the KOTECHA patent teaches that such a step-like resist profile can be obtained using a grey level (scale) mask.

Consequently, combining the process steps of U.S. Patent No. 5,831,266 with the teaching of the KOTECHA patent, which is the application of a grey scale mask for manufacturing a step-like thickness profile in photoresist, will not lead to manufacturing a suspended microstructure having a sloped support with a continuous slope and with a predetermined angle.

The Examiner also alleges that the LAUB patent teaches creation of microstructures with precise control over their size, shape, and position by forming sloping photoresist patterns. The LAUB patent teaches a method for fabricating microbridges making use of the uniform thickness photoresist temporary layer (i.e. there are no two distinctive layers such as a temporary layer and a photoresist layer as in the present patent application) that is shaped using a standard photolithographic process making use of an ordinary binary mask (Figure 4C, column 5, lines 43 to 46). After completion of this operation, the photoresist has a rectangular shape with sharp corners (Figure 4D, column 5, lines 53 to 56). Then, the photoresist is subjected to a reflow, i.e. an intense heating which makes it viscous in such a manner that it flows in accordance with surface tension, and becomes rounded (Figure 4E, column 5, lines 56 to 67). It is known in the art that the viscous flow subjected to surface tension can only create spherical or partial spherical shapes (Figure 4E) without any control over the slopes. This technology is rather simple and it does not allow producing a suspended microstructure with a sloped support having a continuous slope with a predetermined angle. Moreover, contrary to new claim 1 of the present patent application, the shaped photoresist of the LAUB patent is not used for transferring its shape into a different (temporary) layer by etching technique. Furthermore, the photoresist shape of the LAUB patent (Figure 4E) does not show a continuous slope with a predetermined angle. Contrary to that, the shaped photoresist layer 72 and the shaped temporary layer 71 shown in Figures 9B and 9C of the present patent application clearly exhibit a distinctive plateau with two opposite continuous slopes each having a predetermined angle.

Consequently, combining the teaching of the LAUB patent with the teachings of U.S. Patents Nos. 5,831,266 and 5,143,820, still will not lead to manufacturing a suspended microstructure equipped with a sloped support having a continuous slope with a predetermined angle.

According to the Examiner, it would have been obvious to one of ordinary skill in the art at the time the invention was made to carry out the subsequent fourth layer coat by resistive evaporation as taught by TUMA, because this method provides good coating adhesion of thin films suitable for use in manufacturing small devices (sensors, microstructures) (instant claim 9, step (d)). It is believed that the TUMA patent is not pertinent within the context of the present invention. In the present patent application, claim 1 recites a method of fabricating a suspended

microstructure with a sloped support whereas the teaching of the TUMA patent is directed to a detection method integrated with a filtering method and an enhancement method to create a fluorescent sensor. This sensor comprises a thin film geometry including a waveguide layer, a metal film layer and a sensor layer. The thin film geometry of the fluorescent sensor allows the detection of fluorescent radiation over a narrow wavelength interval.

Still according to the Examiner, it would also have been obvious to one of ordinary skill in the art at the time the invention was made to carry out the subsequent fourth layer coating by electroplating as shown by DHULER because this method also provides good coating adhesion in confined spaces encountered in small devices (MEMS arched beams, suspended microstructures) manufacturing (instant claim 9, step (d)). Again, it is asserted that the DHULER document is not pertinent within the context of the present invention, which is directed to a method of fabricating a suspended microstructure with a sloped support. The teaching of the DHULER document is directed to a MEMS actuator that produces significant forces and displacements while consuming a reasonable amount of power. The object of DHULER is to effectively transfer heat from a heater to a metallic arched beam, the metallic arched beam extending over and being spaced, albeit slightly, from the heater. Then, the MEMS actuator effectively converts the heat generated by the heater into mechanical motion of the metallic arched beam. Such teaching has nothing to do with the present invention as claimed in claim 1.

The Examiner rejects former claims 4, 7, 11 and 14-18 of the present patent application as being obvious in view of the teaching of U.S. Patents Nos. 5,831,266; 5,143,820; 5,744,284; 5,841,143; 5,955,817 and 5,559,358 (D. W. BURNS et al.). According to the Examiner, while the first five mentioned patents do not teach deposition of the fifth planarization layer (in addition to the second temporary layer) after manufacturing of a sloped support to make possible subsequent deposition of the sixth structural layer to make a microplatform at a desired elevation above the substrate, the teachings of the BURNS patent would make this obvious to one of ordinary skill in the art.

The BURNS patent teaches a device that employs a resonant member whose vibration motion is coupled to the radiant energy onto a photovoltaic energy conversion device. A preferred form (Figures 1A, 3A, 4A and 5A) of this device has the vibratory member located

within an evacuated capsule. The top cap seals the member off on one side, and the wafer on which it was mounted or formed seals the other (column 3, lines 34 to 37). As shown in Figures 1A, 3A, 4A and 5A of the BURNS patent, there are two cavities, the lower cavity 31 below the vibratory member 40, and the upper cavity 41 above the vibratory member 40. The functioning of the device proposed in the BURNS patent (column 6, line 44 to column 7, line 58) is influenced only by thickness of both cavities h1 and h2, but not by any slopes within these cavities. Thus, any level of control to obtain a continuous slope with a predetermined angle is not even mentioned in the BURNS patent. Furthermore, Figures 9A-G illustrate the manufacturing of the device proposed in the BURNS patent. In particular, Figure 9B illustrates how a planarized temporary layer for manufacturing of the lower cavity below the vibratory member is produced (column 17, lines 47-53, column 18, lines 60-66). There is no temporary layer and there is no planarization layer such as in new claims 1 and 4 of the present patent application. Instead, only the temporary layer is produced twice with the first layer (non planarized) grown and subsequently stripped and then the second (planarized) layer regrown to a similar thickness, resulting in a nearly planar surface for the microbeam (vibratory member) (see column 18, lines 60-66).

Consequently, the U.S. Patent No. 5,559,358 combined with U.S. Patent Nos. 5,831,266; 5,143,820; 5,744,284; 5,841,143; and 5,955,817 do not teach nor suggest all the characteristics of claims 4,7, 11 and 14-18 of the present patent application.

SUMMARY

Applicant asserts that claims 1-18 are now in condition for allowance and respectfully requests a Notice of Allowance to that effect. If the Examiner believes a telephone conference would advance entry of this amendment, please contact the undersigned at the below-listed telephone number.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Claims:

Claims 1, 4 and 15 have been amended as follows:

1. (Amended) A method of fabricating a suspended microstructure with a sloped support, comprising the steps of:

(a) providing a member having three stacked up layers including a first substrate layer, a second temporary layer and a third photoresist layer;

(b) photolithographically transferring a sloped pattern to the third photoresist layer by means of a grey scale mask;

(c) etching the second layer through the third layer resulting from step (b) to obtain a surface with at least one continuous slope with a predetermined angle with respect to the first substrate [surface] layer;

(d) depositing a fourth layer on the previous layers;

(e) etching the fourth layer to obtain the sloped support; and

(f) removing the second layer to obtain the suspended microstructure with the sloped support.

4. (Amended) A method according to claim 1, further comprising, after step (e) and before step (f), steps of:

(i) depositing a fifth planarization layer for covering the previous layers except for a top portion of the sloped support;

(ii) depositing a sixth layer on the previous layers; and

(iii) etching the sixth layer to obtain a suspended microplatform;

wherein step (f) further includes a removal of the fifth layer.

15. (Amended) A method[e] according to claim 14, wherein the polymer is polyimide.